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Scale-up of YBCO Coated Conductor by MOCVD

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Only MOCVD offers advantage of BOTH high deposition rate & large deposition area

<i>Process</i>	<i>Deposition Rate for $J_c > 1 \text{ MA/cm}^2$ (Angstroms/second)</i>
<i>PLD</i>	650
<i>MOCVD</i>	150
<i>E-beam BaF₂</i>	1
<i>MOD</i>	1

Throughput =
Deposition Rate \times Deposition Area

Unlimited Deposition Area with MOCVD:

As long & as wide as showerhead

- **Precursors are separated from Deposition Chamber**
 - **refill is simple (critical for long-length manufacturing)**
 - **no regeneration limits (probably, only MOCVD offers this!)**
- **Precursors are individually controlled**
 - **can tailor composition (off-stoichiometric for high J_c)**
 - **can modify composition during deposition**
- **Coating is not limited by line-of sight**
 - **large area, double-sided coatings possible**

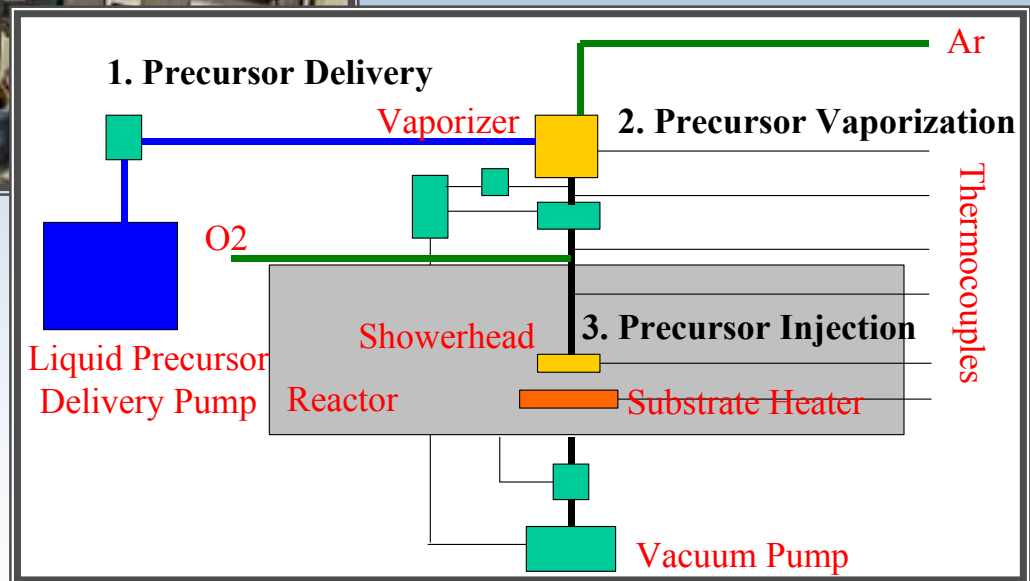
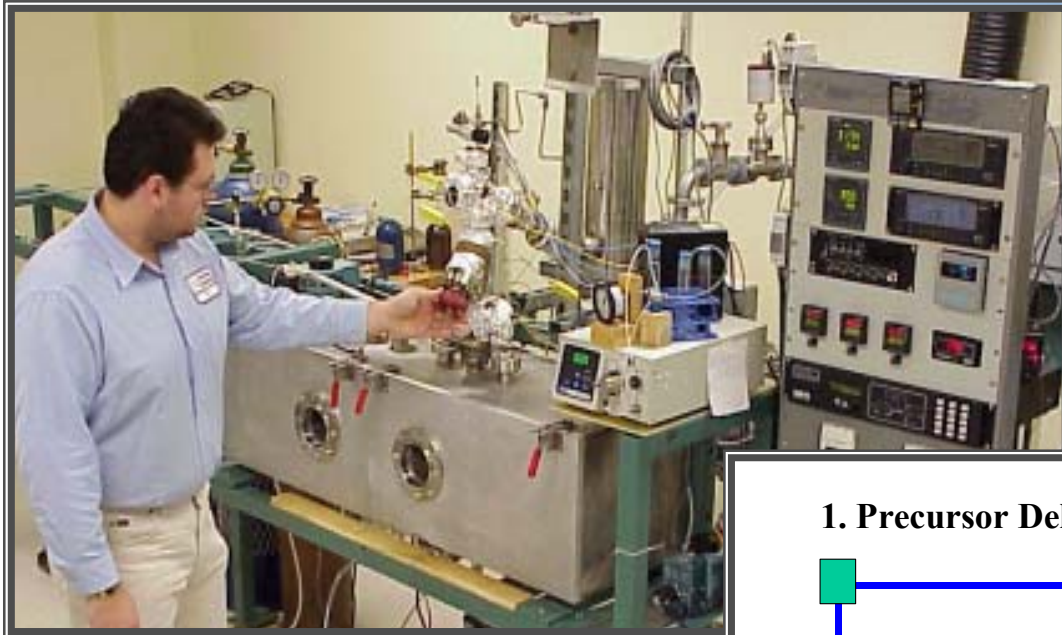
CVD is used as a commercial thin film tape manufacturing process



UNI-SOLAR
United Solar Systems Corp.

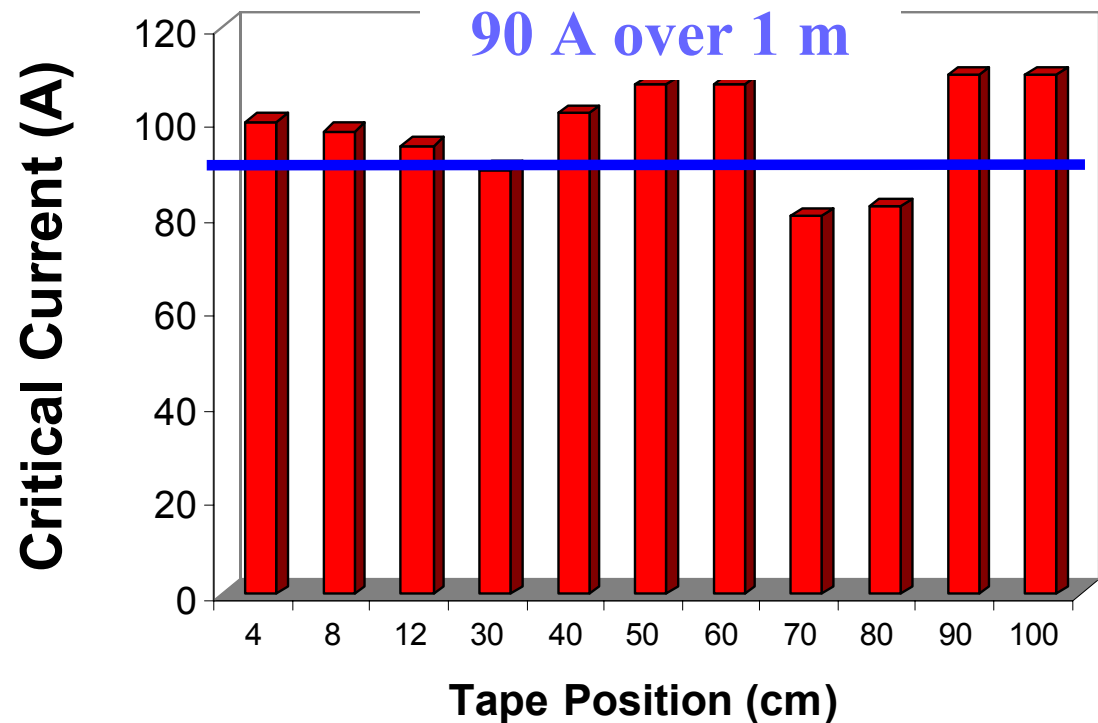
...each of the nine thin-film semiconductor layers is sequentially deposited in separate, dynamically-isolated, plasma enhanced chemical vapor deposition (PECVD) chambers in a continuous roll-to-roll deposition process.

Scale-up of MOCVD for HTS deposition



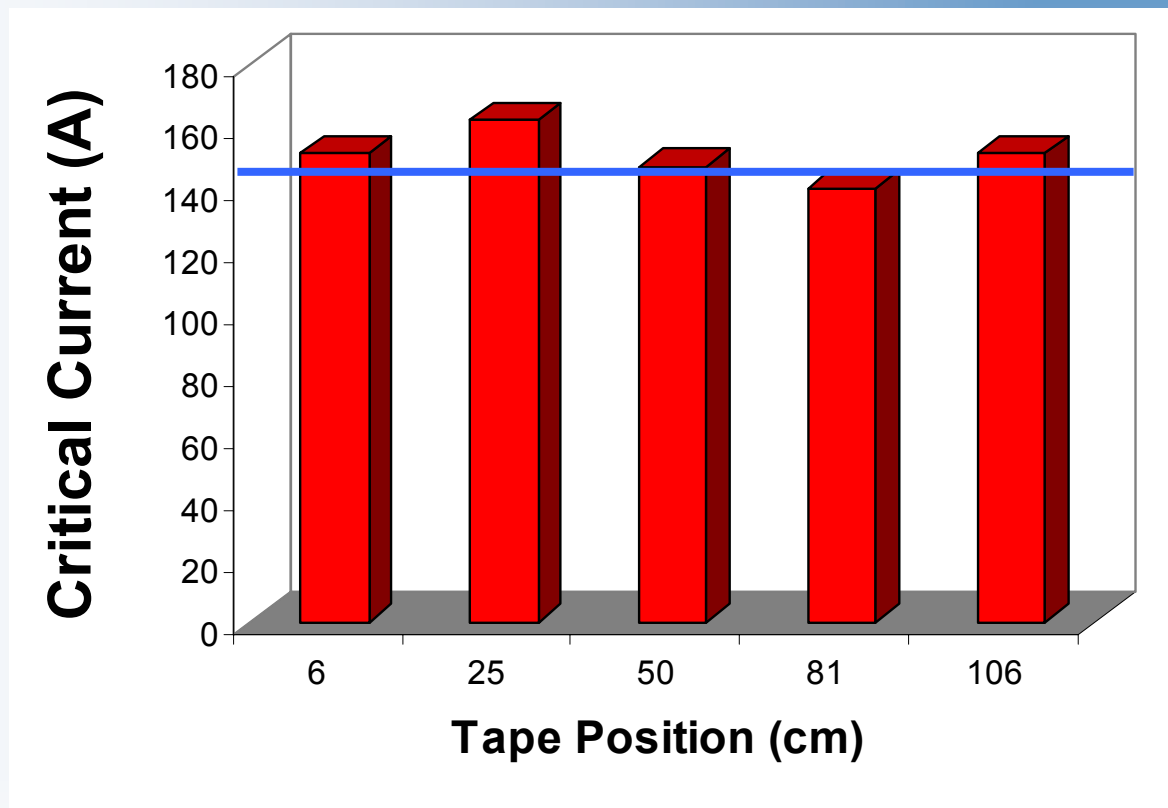
MOCVD process scaled up to meter-long tapes with high currents

<i>IBAD in- plane texture</i>	<i>End-to- end Ic 10 cm (A)</i>	<i>Best Ic section (A)</i>
<i>19°</i>	60	85
<i>16°</i>	85	105
<i>11°</i>	135 (6 cm)	150



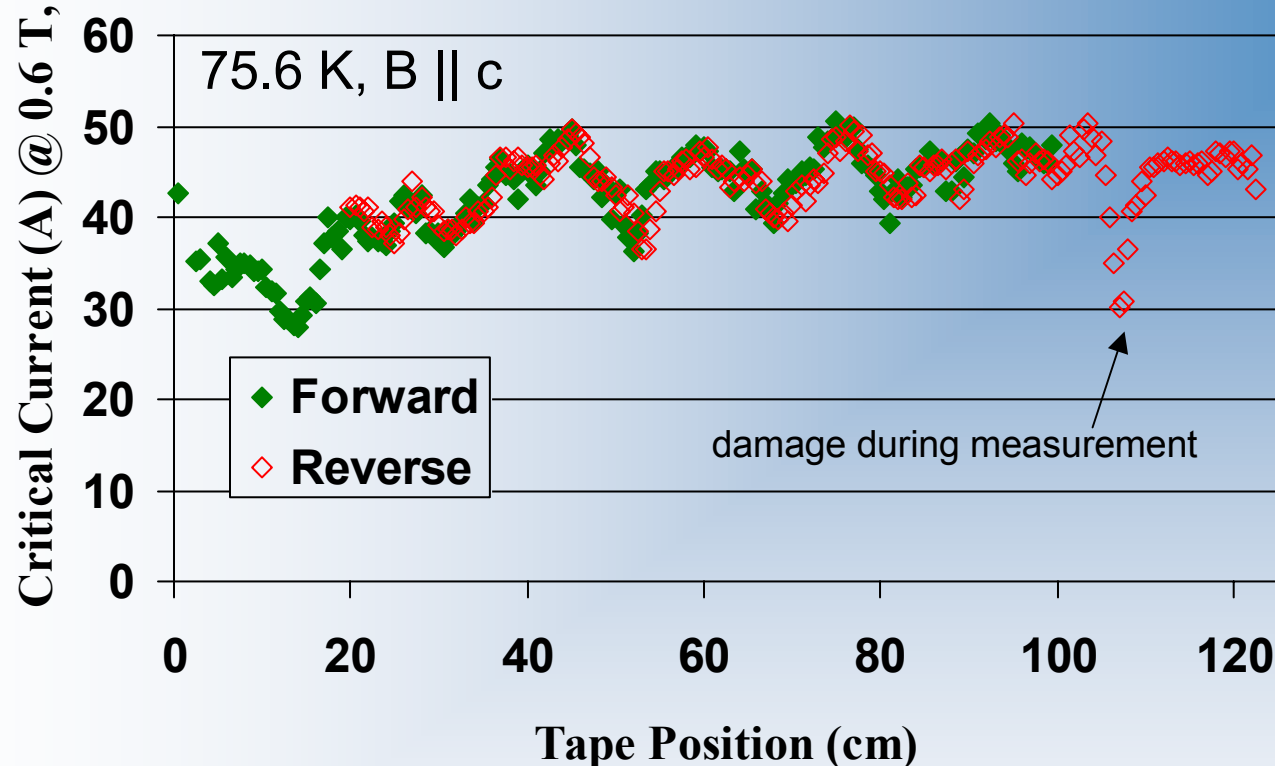
Reported at the DOE Peer Review in July 2002

Progress in high-amperage, meter-long conductor by MOCVD



In Oct.'02, 147 A over 1.06 m

I_c distribution of 1.23 m, 147 A MOCVD tape at 0.6 T in 0.5 cm intervals



Measurement
was done by
Y. Coulter,
L. Civale and
J. Willis of
LANL

Minimum: 28 A at 0.6 T

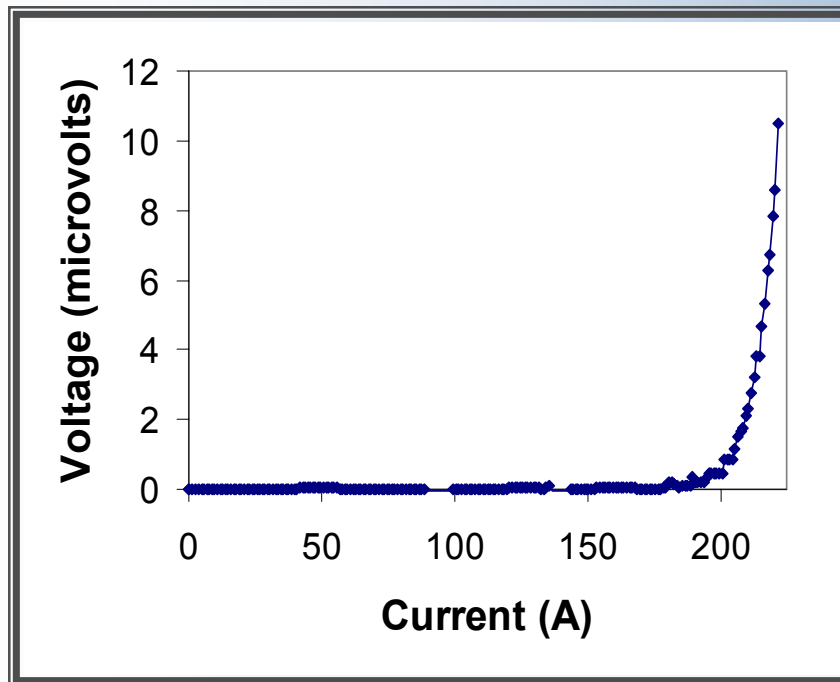
Limits the end-to-end current over 1.23 m to
147 A at self-field

Maximum: 50 A at 0.6 T

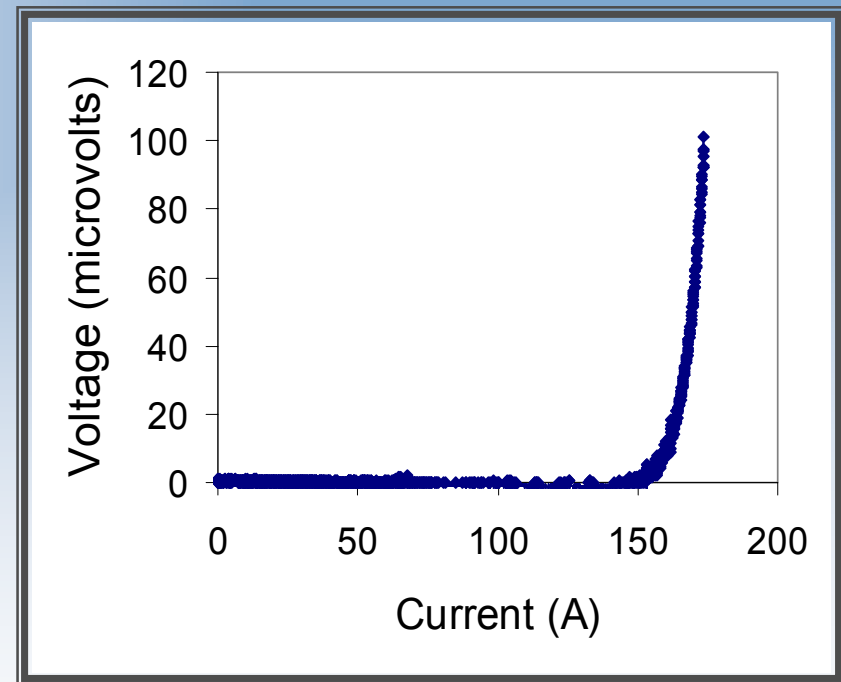
Maximum current is 80% higher;
potential for higher I_c at self-field

Higher currents achieved by MOCVD beyond routine 100 A

205 A over 1 cm

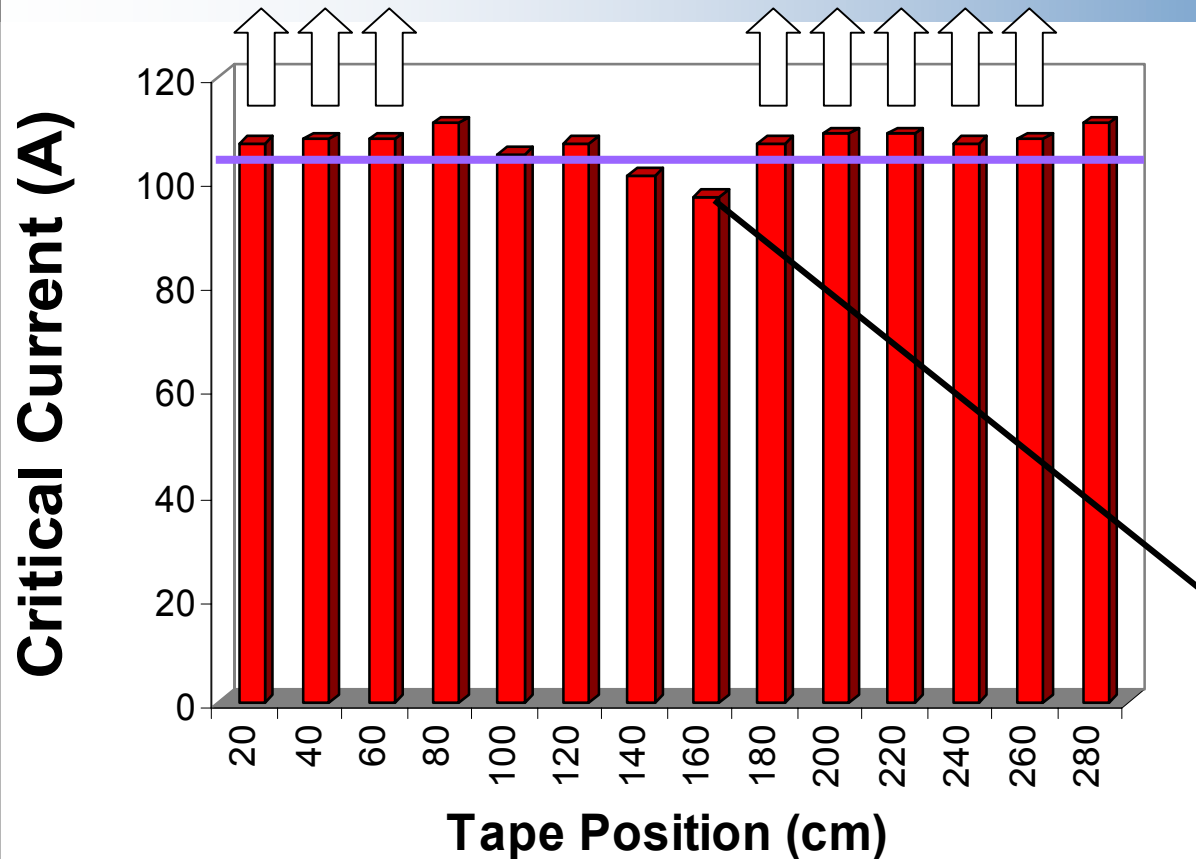


173 A over 1 m

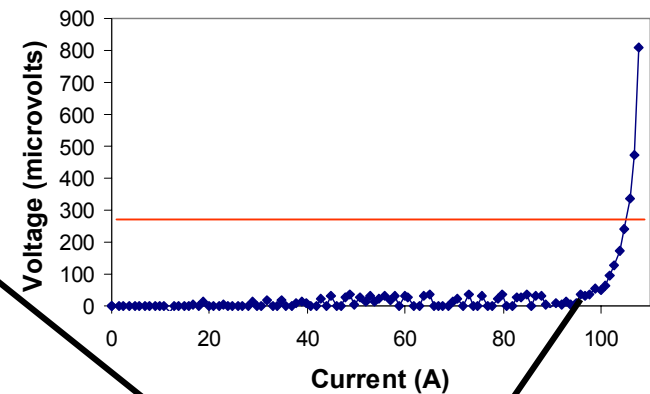


Samples measured from longer piece lengths

100 A Performance achieved in 2.8 m long tapes produced by MOCVD



105 A over 2.8 m



One section < 100 A (97 A)

Issues

- Hardware failure during long runs
- Process stability over long runs
- High critical currents in thick films

Simulation of hardware failure

Run start



Shutdown the system during run



Restart the run



114A over 15cm

High Jc even when run is drastically interrupted !

Process stability: Multi-pass run

Deposit first half thickness of film



Deposit second half thickness of film



120A over 1-meter

No J_c degradation even when process cycle time is reduced to 1/2
With reduced process cycle time, process stability can be increased

Thick Films for high currents

- **Porosity**
- **surface roughness**
- **texture degradation**
- **second phase particles**

**Details will be discussed by J. Reeves at
AFOSR annual review**